

SCIENTIFIC THINKING AND INQUIRY

4.1. Broad Concept: Scientific progress is made by asking relevant questions and conducting careful investigations. As a basis for understanding this concept, and to address the content in this grade, students should develop their own questions and perform investigations.

Students:

1. Recognize and describe how results of similar scientific investigations may turn out differently due to inconsistencies in methods, materials, or observations, or the limitations of the tools used.
2. Explain that clear communication is an essential part of the process of scientific inquiry because it enables scientists to inform others about their work, to expose their ideas to evaluation by other scientists, and to allow scientists to stay informed about scientific discoveries around the world.
3. Use numerical data to describe and compare objects and events.
4. Write descriptions of investigations by using observations as support for explanations.
5. Support statements with ideas and data found in print and electronic media, identify and evaluate the sources used, and expect others to do the same.
6. Identify better reasons for believing something rather than citing comments such as, "Everybody knows that," "I just know," or "Because they say," and discount such reasons when given by others.
7. Explain how scientific thinking can be distorted by strong feelings, and explain why and when it is appropriate or necessary to separate emotions from the reasoning process.

Examples *Students make a poster of charts and graphs to communicate effective nutrition and health habits (4.1.3).*

Students investigate the nutritional value of cafeteria food and compare with snack foods.

Students make recommendations to improve the selection of food in vending machines in terms of its healthiness. They write up their procedures and conclusions (4.1.4).

Students evaluate some medical Q&A advice in the newspaper, TV news, or Internet sites. They compare the different kinds of advice for a particular medical concern and discuss ways to determine how they are true and how they are effective (4.1.5).

Students select an endangered plant or animal, collect information from reference books, decide whether the plant or animal should be saved or allowed to disappear and why, separating emotions from the reasoning process (4.1.6 and 4.1.7).

SCIENCE AND TECHNOLOGY

4.2. Broad Concept: Although each of the human enterprises of science and technology has a character and history of its own, each is dependent on and reinforces the other. As a basis for understanding this concept,

Students:

1. Demonstrate how scientific tools, such as microscopes, telescopes, and cameras, can be used to gather accurate information for making scientific comparisons of objects and events.
2. Discuss and give examples of how technologies, such as computers and medical X-rays, have improved the lives of people.
3. Describe how human beings have made tools and machines, such as X-ray cameras, microscopes, satellites, and computers, to observe and do things that they could not otherwise sense or do at all, or as quickly or efficiently.
4. Make simple and safe electrical circuits with a battery and various plugs, sockets, and terminals.

Examples *Students design and make their own tools: a microscope (using a magnifying glass), a camera (using an oatmeal box to create a pinhole container), and a telescope (using a series of lenses). Students identify and examine objects that they believe they could study by using their tools (4.2.1).*

Students interview a nurse, doctor, or medical technician. They ask the professional to relate stories about their use of technology in medical cases (4.2.2).

Students use a Web site (www.heartsite.com) to examine a wide range of medical uses of technology. They interview family members about their familiarity with such uses (4.2.2).

EARTH SCIENCE

4.3. Broad Concept: Waves, wind, water, and ice shape and reshape the Earth's land surface. As a basis for understanding this concept,

Students:

1. Explain how waves, wind, water, and glacial ice shape and reshape Earth's land surface by eroding rock and soil in some areas and depositing them in other areas.
2. Explain how the surface of the Earth changes over various time scales due to processes, such as erosion and weathering, landslides, volcanic eruptions, earthquakes, and mountain building.

Examples *Students make their own model landscape, using clay as the foundation, which they cover with dirt, grass, and rocks. They allow an ice cube to melt, moving along model hills, to simulate glaciation and a spray bottle to simulate precipitation (4.3.1).*

Students draw a before-and-after picture of their changed landscape, noting the directions and causes of the changes (4.3.2).

EARTH SCIENCE (CONTINUED)

4.4. Broad Concept: The properties of rocks and minerals reflect the processes that formed them. As a basis for understanding this concept,

Students:

1. Define a mineral as a naturally occurring, crystalline inorganic solid substance. Recognize that each mineral has its own characteristic properties (e.g., quartz, mica).
2. Describe the physical properties of minerals, including hardness, color, luster, cleavage, and streak, and recognize that one mineral can be distinguished from another by use of a simplified key.
3. Recognize and describe that most rock is composed of different combinations of one or more minerals.
4. Explain how weathering breaks rocks up into smaller pieces. Recognize that these pieces may be many sizes and shapes, from jagged boulders to smooth grains of sand and even smaller.
5. Describe the different layers of the Earth, including the crust, mantle, and core.
6. Define the three categories of rocks (metamorphic, igneous, and sedimentary) based on how they are formed from older rocks.
7. Explain how soil is made partly from rock weathered by water and wind, and partly from decomposition of plant and animal remains, and that it contains many living organisms.
8. Describe the different properties of soil, including its color, texture (size of particles), and ability to retain water and support the growth of plants.

Examples *Students devise their own classification scheme for common classroom objects: pens, books, people, etc. (4.4.1).*

Students create a class rock collection to display in the classroom. They break, crack, grind, and soak specimens of each variety they find, using magnifiers to locate different sorts of materials in the rocks (4.4.3).

Students melt separate ice cubes with heat, table salt, and water. They examine the different effects of each of those conditions (4.4.4).

Students build a model of the planet, including convection currents in the mantle, as well as plates for the crust. They wrap a small metal ball in another 4 inches of rubber bands, and then they cover that ball with about eight overlapping sheets of aluminum foil (4.4.5).

Students compare pictures of different rock types and hypothesize about the kinds of conditions necessary for their formation using the Web site cln.org/themes/rocks_minerals.html (4.4.6).

Students observe different soil samples using a hand lens to observe color and texture. (4.4.7 and 4.4.8).

PHYSICAL SCIENCE

4.5. Broad Concept: Energy and matter have multiple forms and can be changed from one form to another. As a basis for understanding this concept,

Students:

1. Explain that energy comes from the sun in the form of visible light and other radiation we cannot see without special instruments, but some of what we cannot see we can feel as heating (infrared radiation), and some can cause sunburn (ultraviolet radiation).
2. Investigate and describe how light travels through empty space or a transparent medium in a straight line until it strikes an object, and, if the object is transparent, the light will bend (refract) at the interface.
3. Explain when light strikes a surface, it can be reflected, scattered, refracted, and/or absorbed.
4. Observe and explain that when one object rubs against another (such as one's hands rubbing together) the kinetic energy (energy of motion) is transformed into heat energy.
5. Recognize that heat energy can be absorbed or given off by both living and nonliving things.
6. Explain that energy in fossil fuels comes originally from the energy of sunlight used by plants that grew a long time ago.

Examples *Students examine computer pictures of the sun's radiation in different wavelengths using the Web site www.classzone.com/books/earth_science/terc/content/visualizations/es2601/es2601page01.cfm?chapter_no=26 (4.5.1).*

Students discuss the phenomenon of a "bent" pencil placed in a clear glass container filled with water (4.5.2).

Students shine a flashlight through a lens onto an object that is covered in aluminum foil. They note the reflection from the aluminum foil, the refraction from the lens, the scattering on the wrinkled aluminum foil, and the absorption of that light by their eyes (4.5.2 and 4.5.3).

Students examine how they feel when they sit in warm weather and sunshine and after they complete more strenuous exercise. They compare the absorption and release of heat energy (4.5.5).

Students take an "energy" journey. They pretend they are photons of light that come from the sun, onto a plant, eaten by a dinosaur, which was eaten by another dinosaur. They explain their "energy" journey into forming molecules that made the dinosaur live, move, die, decompose, and reform into a fossil fuel (4.5.6).

PHYSICAL SCIENCE (CONTINUED)

4.6. Broad Concept: Electricity and magnetism are related phenomena that have many useful applications in everyday life. As a basis for understanding this concept,

Students:

1. Recognize that some materials are electrical conductors and others are electrical insulators.
2. Demonstrate that magnets attract objects made of iron and a few other substances (called *magnetic materials*), but they do not attract objects made of most other substances.
3. Investigate and describe that a magnet does not have to touch an object made of magnetic material to exert a force on it.
4. Describe that magnets have poles; unlike poles of two magnets attract each other while like poles repel.
5. Explain how an electrically charged object does not have to touch another object to exert a force – called the *electrostatic force* – on it.
6. Recognize that there are two types of electric charge: *positive* and *negative*.
7. Explain that if two electrically charged objects are near each other, each will exert an attractive or repulsive force on the other. Describe that like charges repel each other and unlike charges attract each other.
8. In spite of some similarities, explain how the electrostatic force and the magnetic force are not the same thing.
9. Explain that electric current can flow only if there is a complete closed loop of conducting material (called a *circuit*) for it to flow through. Know that a switch is a device for opening and closing a circuit.
10. Explain how electrical energy can be used to produce light, heat energy, motion (kinetic energy), or sound energy.

Examples *Students observe the static electricity caused by rubbing a wood, glass, rubber, and metal rod with a piece of cloth. They rub a blown-up balloon on their hair. They run a comb through their hair. They note the effect of holding these objects close to a thin stream of water running from a faucet (4.6.1 and 4.6.5).*

Over a large piece of paper, students maneuver staples, paper clips, pins, pencils, and erasers into position by bringing one or more magnets closer to the objects. They draw the direction of the movement on the paper beneath (4.6.2).

Students place a magnet underneath a piece of cardboard to determine whether there is a magnetic force through the material to move an object (4.6.3).

Students maneuver one magnet with another into a target location (4.6.4).

Students examine the structure of a dead lightbulb (4.6.9).

Students discuss the anatomy of a computer and its use of electrical energy (4.6.10).

LIFE SCIENCE

4.7. Broad Concept: All organisms need energy and matter to live and grow. As a basis for understanding this concept,

Students:

1. Explain that organisms interact with one another in various ways, such as providing food, pollination, and seed dispersal.
2. Observe and recognize that some source of energy is needed for all organisms to stay alive and grow.
3. Describe how energy derived from the sun is used by green plants to produce chemical energy in the form of sugars (photosynthesis), and this energy is transferred along a food chain from producers (plants) to consumers to decomposers.
4. Observe and explain that most plants produce far more seeds than actually grow into new plants.
5. Describe the structures in plants (leaves, roots, flowers, stem, bark, wood) that are responsible for food production, support, water transport, growth, and protection.
6. Describe the many beneficial attributes of plants, including trees, in improving and sustaining an urban environment.
7. Explain how in all environments, organisms grow, die, and decay, as new organisms are produced by the older ones.
8. Recognize that there are many kinds, and vast numbers, of living things too small to see with the naked eye called *microorganisms*, but they can be easily seen with the aid of various kinds of microscopes.
9. Explain how dead plants and animals are the food source for many microorganisms.
10. Investigate the Chesapeake Bay watershed and wetlands, and describe how they support a wide variety of plant and animal life that interact with other living and nonliving things.

Examples *Students cut up and eat oranges, watermelons, cucumbers, or tomatoes. They discuss the space and conditions needed for all those seeds to grow and thrive (4.7.4).*

Students plant bean seeds in soil and vary the amount of water given to certain plants to observe water transport through their roots (4.7.5).

Students build a model of a riparian buffer (a stretch of plants that runs between a stream and land), which can absorb materials that would have entered the water. They make model hills of clay and use astroturf or Velcro as the buffer (4.7.6).

Students bury a dead insect or plant. They note the position, and dig up the remains for examination every two weeks (4.7.7).

Students examine stream water samples, as well as swabbed saliva from the inside of student mouths, using a microscope. Students use the cell magnification on www.cellsalive.com/howbig.htm to help them understand the scale (4.7.8).

Students build a compost bin and record observations over time (4.7.9).

LIFE SCIENCE (CONTINUED)

4.8. Broad Concept: Humans have a variety of mechanisms to combat disease. As a basis for understanding this concept,

Students:

1. Describe that human beings have body systems very similar to those of other animals, especially other mammals (warm-blooded vertebrate animals that have, in the female, milk-secreting organs for feeding the young).
2. Explain that some diseases are caused by germs (harmful microorganisms such as some bacteria and viruses) and some are not, and those caused by microorganisms may be spread to other people.
3. Explain that disease-bearing microorganisms, called *pathogens*, can enter the body and interfere with the proper function of various parts of the body.
4. Recognize that there are beneficial microorganisms, such as normal intestinal flora.
5. Explain that washing hands with soap and water reduces the number of pathogens that can get into the body or that can be passed on to other people.
6. Describe the body's defenses against pathogens, including tears, saliva, skin, some types of white blood cells, stomach secretions, and an internal system of chemical testing.
7. Explain that a healthy body can fight most invasive pathogens; however, some interfere with the body's defenses.
8. Identify diseases that human beings can usually catch only once because their bodies build up an immunity to them.
9. Recognize that vaccines can prevent some diseases so that people do not catch them at all.

Examples *Students use an interactive Internet site to solve medical mysteries and prevent the spread of infectious diseases (medmyst.rice.edu/html/mission1.html) (4.8.2, 4.8.3, 4.8.6, and 4.8.7).*

Students simulate how germs are spread through a sneeze: They lightly dust a desk with powder.

Students discuss the number and kinds of touches that area would receive in one day and where that powder could travel in one day in school (4.8.5).

Students discuss the causes and symptoms of their allergies and research the external response system (4.8.6).

Students research different vaccinations (www.cdc.gov) and check out which vaccinations they had. They compare their experience of health care with that of children in other parts of the world (4.8.9).

Students interview older family members about their medical history (4.8.9).